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A Comparative Study of Multivariate Analysis for Selection and Classification Using Fuzzy Measures and Reasoning

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13. ABSTRACT *(Maximum 200 words)*
This study develops a set of decision-making tools to be used by the Navy, commercial and private enterprise to select and classify recruits and/or employees. As an addition to or potential replacement for the current Navy selection and classification process, this process utilizes current research in the latest decision support techniques. Multiple methods are tested using discriminate analysis, multiple criteria decision making, fuzzy and evidence reasoning. The study allows decision-makers to combine both qualitative and qualitative information on a sailor's skills, competencies, and experiences to select recruits. The data from the selection process can be utilized to classify recruits using a computer-based algorithm. We focus on fuzzy MADM as the primary tool for combining multiple input attributes which may be crisp or uncertain. The major scientific merit of this study is that we advance the area of decision making under uncertainty by providing a fuzzy modeling framework and computation structure.

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FINAL TECHNICAL REPORT

GRANT #: N00014-00-1-0769

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INSTITUTION: Kansas State University

GRANT TITLE: A Comparative Study of Multivariate Analysis for Selection and Classification Using Fuzzy Measures and Reasoning

AWARD PERIOD: July 1, 2000 to September 30, 2001

OBJECTIVE:
The objective of this study is to provide a methodology by which the Navy can select recruits and classify recruits. The proposed method considers all input factors over time, including "crisp" and fuzzy linguistic variables to provide not just a solution but rather a set of possible solutions ranked by possibility scores generated from a fuzzy MADM. The goal is to take into consideration the recruit's "whole person" profile including the ASVAB, job specific skills, social understandings, motivation, leadership and other test scores. Research results can also be generalized to other personnel questions, such as corporate recruiting/job assignment.

APPROACH:
We conducted a literature search to identify all works done related to selection and classification problems in industry or the military. A set of mathematical expressions was developed to model and describe selection and classification problems. Based on the problem description, we improved and developed a fuzzy MADM method based on Siskos, Lochard and Lombard's work (1984). The proposed methods as well as other popular MADM methods are compared and validated by a few sample problems. Finally, we implement all methodologies via two sets of computer programs – Microsoft's Visual C++ and Mathwork's Matlab.

> Siskos, J.L., J. Lochard and J. Lombard (1984), "A Multicriteria Decision-Making
> methodology under fuzziness: Application to the evaluation of radiological
> protection in nuclear power plants", *TIMS/studies in the Management Sciences,* 20, pp
> 261-283.

ACCOMPLISHMENTS (throughout award period):
In this project, we have advanced the area of decision making under uncertainty by providing a fuzzy modeling framework and computation structure. The proposed algorithm can handle both crisp and uncertain input data, such as the motivation input. The pair-wise comparisons for each attribute and all candidates are concatenated to provide a comprehensive overall evaluation. The end results are rankings for each job posting. The computer programs make the task easy to conduct any MADM problem. Finally, we also studied the limits of the proposed method due to computational complexity.

CONCLUSIONS:

We compared various methods related to selection and classification and found many methods are not appropriate for this application. For example, a popular statistical method is called discriminate analysis (DA) which is often used to cluster subjects/candidates of similar attributes together. DA is not appropriate for selection and classification problems in that the best candidate within a clustered group is that closest to the "center" of the group. In other words, a decision maker would end up picking the most "average" candidate within a group. On the other hand, the proposed fuzzy MADM method compares all candidates in a pair-wise fashion. Each candidate would be assigned a fuzzy score which considers the relative and global strength in term of all attributes and other candidates. The final results are much more appropriate for a selection and classification problem. Furthermore, the proposed method is capable of computation of qualitative as well as quantitative attributes which are very relevant to the future Navy vision of "whole person" profile for personnel. A whole person profile would consist of both test scores and other qualitative attributes, such as, leadership, motivation, and spatial skills, etc. With the large numbers of Navy personnel assigned each year and complexity of whole person profile system, the proposed method provides a scientific decision making methodology to seek out best candidates for vacant positions.

SIGNIFICANCE:

There is a need for improvement in the selection and classification of workers not only in military but also in private sectors. Currently organizations often are just hiring "warm bodies." Although there is some degree of success using the hit or miss approach, those companies who are better in recruiting are those who have more sophisticated interview techniques and tests for aptitude and ability. The military is more integrated in recruiting than many private companies. However, there is a lot of room for improvement in "hiring processes" for both type of organizations. We believe that we have advanced the area of decision making under uncertainty by the study of fuzzy outranking with uncertainty inputs and the corresponding computation algorithm. Our work is very promising in solving large classification problems consistently although more research is needed to improve computational time for problems with extremely large data such as ten thousand candidates with 200 attributes.

PATENT INFORMATION: No patent is applied.

AWARD INFORMATION: None.

REFEREED PUBLICATIONS (for total award period):

Shih, H. S. and Lee, E. S. (2001). "Discrete Multi-level Programming," *Dynamic Aspects in Fuzzy Decision Making*, Yuji Yoshida (ed.), Springer Verlag, NY.

BOOK CHAPTERS, SUBMISSIONS, ABSTRACTS AND OTHER PUBLICATIONS (for total award period)

Aouam, T., Lee, E.S., Chang, S., and Hanna, S. (2001), Fuzzy MADM: An outranking relation using the Overall Existence Ranking Index, internal report, Department of Industrial and Manufacturing Systems Engineering, Kansas State University, Manhattan, KS.

Aouam, T. (2001), Fuzzy Outranking Methods For Multiple Attribute Decision Making, MS thesis, Department of Industrial and Manufacturing Systems Engineering, Kansas State University, Manhattan, KS.

Aouam, T. Chang, S. and Lee, E.S., "Fuzzy MADM: An Outranking Method," submitted to *European Journal of Operations Research.*